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An Interhiatal Population of *Pseudacris streckeri* from Illinois, with an Assessment of Its Postglacial Dispersion History

RALPH W. AXTELL* AND NORMAN HASKELL**

At present the Illinois chorus frog, *Pseudacris streckeri illinoensis* Smith, is known from two sizable population concentrations separated by a hiatus of over 300 linear kilometers. The southern concentration occurs on the Mississippi-Ohio River floodplain of extreme southern Illinois, adjacent Missouri and nearby Arkansas (Smith, 1955, 1966; Holman, et al., 1964; Brown and Brown, 1973), while the northern concentration is associated with the Illinois River floodplain of western central Illinois (Smith, 1951, 1961; Moll, 1962; see Fig. 1). In both these regions two environmental factors appear consistent: 1) occurrence on a floodplain, and 2) an association with sands either deposited by water (fluvial) or wind blown (aeolian). Brown, et al. (1972) have demonstrated experimentally that *P. streckeri* burrows (using its anterior limbs) rapidly in sandy soils, but it is unable to penetrate sod, or any other moderately compacted soil (pers. obs.). We believe, as did Smith (1966) and Brown et al. (1972) that soil type is an important factor governing the distributional limits of this anuran.

Considering the above constraints, it would seem reasonable to presume that the floodplain of the Mississippi below the confluence of the Mississippi and Illinois Rivers served as the dispersal avenue originally connecting these now disjunct populations. Such a presumption would have more credibility, of course, if additional *P. streckeri* populations could be found between those already known. One of us (RWA) has long considered the "Cahokia crescent" (where the Mississippi floodplain describes an abrupt eastward arc north and east of St. Louis, Missouri) as a particularly suitable region to search for additional populations of *P. streckeri*. In this area there are numerous fluvial sand deposits formed along old river meanders. Years of erratic searching had produced only indefinite evidence (probable vocalizations) that *P. streckeri* was in the area. Then on 28 April 1975, the junior author, while digging for lizards (*Cnemidophorus sexlineatus*), unearthed a buried individual on the northern outskirts of Granite City, Madison County, Illinois. Additional searching during the spring and summer months produced no further frogs, but on 9 November 1975, Haskell collected two additional buried individuals. As virtually nothing is known of the

*Dept. of Biological Sciences, Southern Illinois University, Edwardsville, Illinois 62026.

**2102 Fernwood Place, Alton, Illinois 62002.

nonbreeding habits of this frog, we present here information accumulated during our brief acquaintance with this population.

All three frogs were found in lenticular sand deposits (ca. three meters wide by 20 m long) some 12 meters from and parallel to an active railroad right-of-way. The sand strips are surrounded by dark fluvial alluvium of low sand content, so the amount of potential burrowing habitat in the area appears very limited. Most of the sands are mixed with railroad cinder debris producing a darker, courser sand than is found in other such deposits in the area. Vegetative cover is mainly weedy annuals (ca. 1 m high) with patches of short grass (*Bromus*, *Aristida*) mostly growing on the sands. All the frogs had left surface traces of their burrowing activity; indeed, this is how they were found. The first individual found, an adult male (SIDE 2616), came from ca. 15 cm below a flat sandy surface, almost directly under a shallow depression ca. 18 mm wide by 20 mm deep. Ground surface around the depression was devoid of vegetation. Both frogs taken in November were gravid females. One (SIDE 2617) came from within 20 m of the male location (see above). This individual was situated ca. 20 cm deep but laterally offset nearly 10 cm from a shallow surface depression (ca. 50 mm wide by 10 mm deep) with a slight rim about its perimeter. The depression was on a slight rise and within 5 cm of grass cover. The second female (SIDE 2618) came from a deposit nearly 100 m south of the first site, near a backwater area. She was located ca. 15 cm below a flat surface, almost directly beneath a very shallow surface depression (ca. 20 mm wide by 3 mm deep). The immediate vicinity of this trace was also devoid of vegetation.

The depths at which these frogs were unearthed suggest that they were not in overwintering positions. As frost depth in the Granite City region occasionally exceeds 15 cm we consider it doubtful that winter hibernation normally takes place at such shallow depths. The fact that all three individuals had left surface traces of their burrowing suggests that above ground activity must have taken place recently, for both wind and precipitation probably obliterate such traces quickly. We suspect, therefore, that these frogs were either in temporary burrows or in hibernating burrows at prehibernation depths.

Examination of the two females taken on 9 November, indicated that both were in an advanced reproductive state. Their abdominal cavities were fully distended with yolked ova. Such a situation tempts us to wonder whether *P. streckeri* might practice fall oviposition in the St. Louis area. Fall precipitation in the area is quite adequate through November and December and such a practice would have considerable adaptive significance during years of inadequate spring rainfall. Carol Axtell (pers. comm.) has accumulated considerable evidence that both *Rana blairi* and *R. sphenoccephala* practice fall oviposition with larval overwintering in the St. Louis region, and it is known that *P. s. streckeri* regularly practices fall oviposition in eastern Texas (unpub. data).

Since its discovery we have continued to monitor the Granite City population hoping to determine its size and where it reproduces. During March and April 1976, the site was visited after each substantial rain.

(20 mm or more), but no audible calls were detected (winter and spring precipitation was considerably lower than normal in 1976). *Pseudacris triseriata*, *Bufo americanus* and *Rana* sp. were all vocalizing in the area, however. On 11 March 1977, after ca. 40 mm of rain, we heard one or perhaps two males calling while we were ca. 100 m away from the site. Vocalization ceased as we approached from a different direction and further attempts to accurately locate the call site were unsuccessful. Our orientation toward the original calls indicated that they were coming from a small, shallow, ephemeral pond near the tracks and not from an extensively flooded nearby human-modified habitat. This evidence suggests that the Granite City *P. streckeri* population is probably quite small and is certainly in need of protection if it is to survive. The intensive and growing urbanization of the area mitigates against this, however.

On the brighter side, field work during spring 1977 indicates that *P. streckeri* is rather widely distributed in the entire northern section of the "Cahokia crescent," and in considerable numbers. After heavy rains on 28 March 1977, one of us (RWA) heard vocalizations from at least five separate populations within a 15 km² area. All were on the Mississippi floodplain and all were near sandy or loamy soils. Vouchers (SIDE 2619-21) were taken from only two of these populations.

Morphologically the specimens (N = 6) thus far collected are characteristic of *P. s. illinoensis*, but they differ from previous descriptions in one important way yellow lipophores were present on the thighs and posterior flanks of all specimens before preservation. The yellow tint is variable, however, being quite distinct in some but virtually absent in others. From the small sample thus far examined it appears that the yellow coloration is less developed in the females. As absence of this coloration was considered an important diagnostic feature when this race was first described (Smith, 1951), its usefulness in diagnosis is negated by this finding. We do recognize, however, the pallid aspect of these lipophores, the complete absence of the rusty lipophores and greenish iridophores, and the absence of dark melanophore reticulations on the posterodorsal thigh (all of which are characteristic of *P. s. streckeri*), as features that can be used in combination to separate this assemblage from all others presently known. Therefore, we continue to recognize *P. s. illinoensis* as a distinguishable, albeit weakly differentiated race.

Except for one morphometric ratio, all the specimens fall within established limits of variation for *P. s. illinoensis*. One female has a slightly larger tibia to snout-vent ratio (tib./SVL = 0.441) than has previously been reported (tib./SVL = 0.424 ; Smith, 1961).

The discovery of interhiatal populations in the "Cahokia crescent" adds weight to the postulate that the Mississippi floodplain was an avenue along which *P. streckeri* dispersed during some earlier period. If the floodway indeed served as a dispersal pathway, the direction of immigration along it becomes of some zoogeographic interest.

POSTGLACIAL DISPERSAL HISTORY

P. W. Smith (1957 : 211) considered the disjunct central Illinois and southern Missouri *P. streckeri* populations "prairie peninsula" relicts that had been derived earlier from Great Plains ancestors. During the

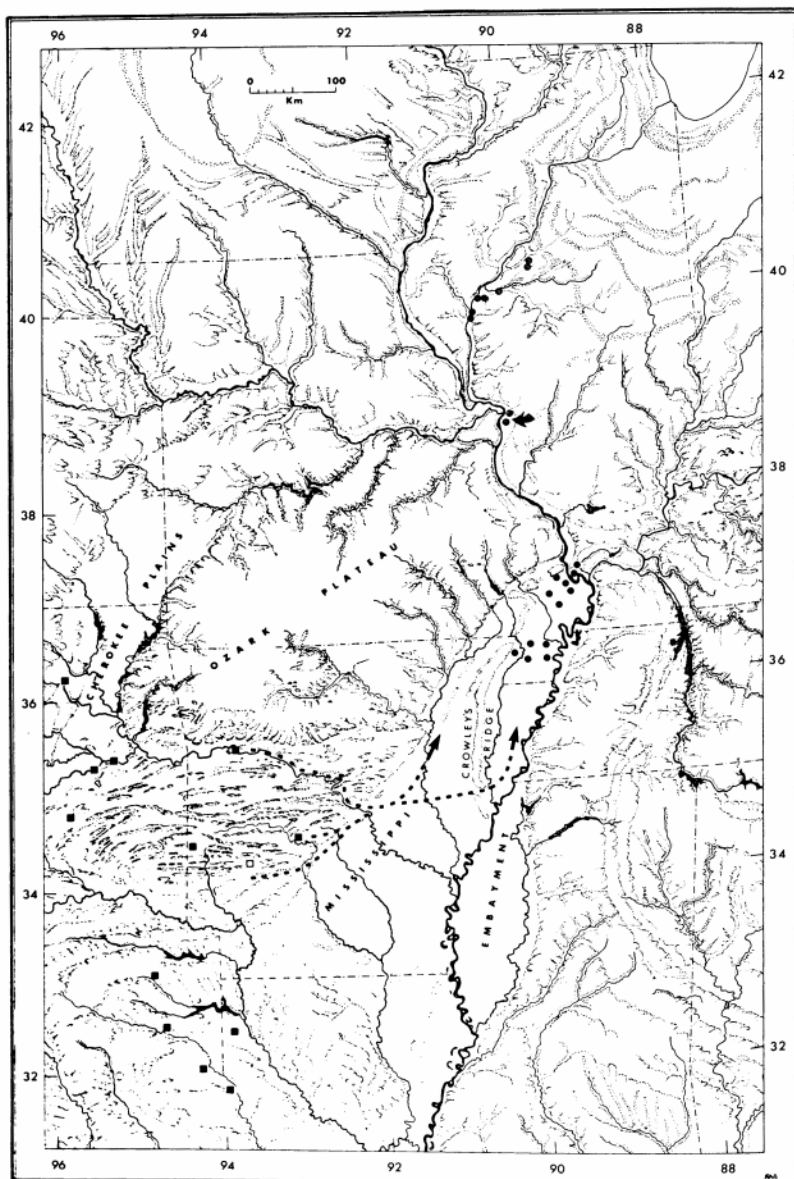


Figure 1. Simplified relief diagram adapted from Raisz (1957) depicting voucher (solid symbols) and auditory (hollow symbol) records for *P. s. illinoensis* (dots) and *P. s. streckeri* (squares). Dashed lines in central Arkansas indicate hypothetical dispersal avenues proposed in text.

Xerothermic, a warm, generally dry period lasting from about 6,000 to 4,000 BP, he postulated massive easterly expansion of numerous Great Plains vertebrates. This expansion was later followed by a contractive isolating phase brought on by the cooler and more mesic conditions during post-Xerothermic time. We may infer from Smith's maps (p. 211) that he visualized populations expanding along rather broad fronts which were little influenced by habitat diversity or terrain. For the organisms expanding into the prairie peninsula he indicated either trans-Ozarkan or more northerly grassland dispersal routes for all the forms considered. Because of the general nature of Smith's thesis we fully understand his broad-stroke approach to dispersal, so what we proposed here is a refinement (as it applies to one organism) of Smith's original hypothesis, with certain intuitive rationalizations about environmental constraints added. As far as *P. streckeri* is concerned the evidence thus far accumulated does not support the broad-front dispersal hypothesis. As *P. s. illinoensis* appears limited environmentally to both sandy substrate and floodplain-like topography, we believe that any hypothesis formulated to "explain" its early dispersal must take these factors into consideration. Accordingly, we have sought probable west-east dispersal avenues which generally meet these criteria. The most probable routes appear to be (from south to north): 1) The Tertiary and Cretaceous littoral formations that outcrop across northeastern Texas, adjacent Louisiana, Oklahoma, and Arkansas, 2) the outwash sediments of Paleozoic sandstones in the Ouachita Mountains of southeastern Oklahoma and adjacent Arkansas, 3) the Arkansas River floodway of west-central Arkansas, and 4) the Osage-Missouri-Kansas floodways of eastern Kansas and west-central Missouri. We shall evaluate each of these briefly: 1) The ancient beach and littoral formations provide an almost continuous upland sand-covered corridor (Stose and Ljungstedt, 1932) from Texas to central Arkansas (Fig. 1). There is good evidence that these formations now support isolated *P. streckeri* populations. The Caddo Parish, Louisiana record reported by Morizot and Douglas (1967) fits this category, as do vocalizations heard by one of us (RWA) between Ashdown, Little River Co. and Murfreesboro, Pike Co., Arkansas, along state highway 27. No vouchers were taken in the latter case, so these records remain tentative until substantiated. 2) Farther northward in Arkansas, we have located two little known vouchers from the Ouachita Mountains region. One of these (OSU-A 1613) is from 3.2 km (2 mi) southwest of Cole (= Cove), Polk Co., the other comes from Hot Springs, Garland Co. (TU 2478)¹. Both shales and sandstones outcrop in these areas (Thornbury, 1965), so we surmise that these specimens came from areas of outwash or resedimentation of the sand. 3) The Arkansas River drains extensive regions inhabited by *P. s. streckeri* populations in central and eastern Oklahoma (Conant, 1975), and its floodway provides a natural lowland dispersal avenue through west-central Arkansas. Specimens from 4.8 km (3 mi) south of Ozark; Franklin Co., Arkansas (I N H S 9729-8), provide evidence for existing populations on this floodplain. Finally, the Osage-Missouri-Kansas River system drains much of eastern Kansas and practically all of west-central and northern Missouri, yet we

find no evidence that *P. streckeri* has ever existed in this region, or indeed ever reached it. We attribute this to the extensive areas of non-arenicolous substrate on the "Cherokee Plains" (see Raisz, 1957) occurring throughout southeastern Kansas and adjacent Missouri. We believe that a substrate barrier would have been an effective deterrent to any north-eastward dispersion of chorus frog populations.

Additionally, we consider the Ozark uplands as equally unfavorable for past or potential *P. streckeri* habitation. The erosion and degradation of limestone, which underlies most of the western Ozarks, does not produce the type of substrate apparently required by northern populations of this anuran. We hasten to add, however, that this generalization does not obtain throughout the entire range of *P. streckeri*, for there are Texas populations that inhabit limestone regions (Axtell, pers. obs.).

The evidence garnered to date favors the Arkansas floodway as the most probable avenue of eastward range expansion during the Xerothermic. However, the more southerly Ouachita and coastal plains populations might well have contributed genes to populations farther north or east by routes that have either disappeared (by erosion) or have yet to be discovered.

Having reached the Mississippi lowlands, *P. streckeri* could have spread northward either east or west of Crowley's Ridge, a conspicuous Tertiary sedimentary remnant separating the ancestral Mississippi and Ohio River floodways (Fisk, 1944, Fig. 1). Curiously, all southern Illinois, Missouri and northeastern Arkansas populations thus far reported have come from sand deposits seemingly associated with the abandoned Cache Valley course of the early Ohio River (Fisk, 1944) or its flood diversion (Alexander and Prior, 1968). Although there are abundant fluvial sand deposits along the early Mississippi floodway to the west of Crowley's Ridge, *P. streckeri* has never been found in these. The significance of this curious distributional phenomenon presently eludes us.

CONCLUSIONS

1) Current evidence indicates that sand is one of the factors basic to most *P. streckeri* distribution. The percentage of silica granules to other included components has yet to be resolved, but it is probably fairly high.

2) If *P. s. illinoensis* (see below) was derived from western *P. s. streckeri*, this presumably took place somewhat farther south than Smith (1957) originally suggested that is, along the Arkansas River floodway, the arenicolous deposits of the Ouachita roughlands, or the coastal plain uplands.

3) After reaching the Mississippi Embayment the evidence indicates northward movement along narrow tracts of suitable floodplain habitat to at least central Illinois. We can predict, therefore, that other populations probably exist and will eventually be found along this dispersal avenue.

COMMENTS

Both Smith's (1957) hypothesis and our own make the *a priori* assumption that *P. s. illinoensis* has been derived from *P. s. streckeri* to

the west, yet no one has presented evidence that this indeed is the case. As *Pseudacris streckeri* and *P. ornata* are closely related, with complementary though non-contiguous ranges (*P. ornata* occurs in similar arenicolous habitat along the eastern Gulf Coastal Plain), one cannot completely ignore the possibility that *P. s. illinoensis* might be a primitive relict of an original northern connection between these two species. In this case *P. s. illinoensis* may have actually given rise to *P. s. streckeri*!

Finally, we cannot help but notice the distributional similarities between *P. streckeri* and the western hognose snake, *Heterodon nasicus*, another of Smith's (1957) prairie peninsula examples. Although direct western derivation seems more probable in this case, it seems curious that the southeastern Missouri-Southern Illinois examples (on the Mississippi floodplain) are representatives of the southwestern race *H. n. gloydii* rather than the Great Plains *H. n. nasicus* (see map 129 in Conant, 1975). *H. nasicus* also has a strong preference for sandy substrate over much of its range (RWA, pers. obs.).

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MAP VOUCHERS

Included on the map (Fig. 1) are the following unpublished records (adjoining records shown as one) : **ARKANSAS:** *Clay Co.* —8 km SSE Greenway (INHS 9725-6). **ILLINOIS:** *Madison Co.* 38° 43' N-90° 07' W—N Granite City (SIUE 2616-18) ; 38° 46' N-90° 01' W—SE Poag (SIUE 2620-21) ; 38° 49' N-30° 02' W—NW Poag (SIUE 2619). **MISSOURI:** *Dunklin Co.* city limits Kennett (KU 90705) ; 1.6 km W Kennett (KU 90706-30) ; 6.4 km NE. White Oak (INHS 9722). *Mississippi Co.* 1.6 km S. Charleston (KU 90733-7) ; 4.8 km NE East Prairie (INNS 9720). *New Madrid Co.* 4 km E. Matthews (INHS 9723-24). *Pemiscot Co.*, 1.6 km W. Hayti (KU 90731-2) ; 4.8 km NE Wardell (INHS 9717-19). **OKLAHOMA:** *McIntosh Co.* 3.2 km NW. Duchess at Eufaula Dam (SFA 3375). *Pittsburg Co.* 3.2 km NE. Canadian (RWA sight) ; 3.2 km SE Kiowa (RWA sight). *Tulsa Co.*—(AMNH 52514-15). **TEXAS:** *Gregg Co.* —Longview city limits (SFA 227). *Panola Co.*—Jct. FM 10 & 999 at Gary (SFA 2655-57). *Shelby Co.*—Hurstown, 16.1 km NE. in Sabine Nat. For. (SFA 3716).